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U.S.D.A. FOREST SERVICE
RESEARCH NOTE RM- 245

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE

OCKY MOUNTAIN FOREST AND RANGE EXPERIMENT STATION

Revegetating Coal Mine Spoils in New Mexico: *A Laboratory Study*

Earl F. Aldon and H. W. Springfield[1]

Emergence and early growth of mountain rye and fourwing saltbush were studied in untreated 3-year-old mine spoils, and in spoils to which organic matter or fertilizer had been added under greenhouse conditions. Emergence and growth were satisfactory from untreated spoils; adding amendments had no effect on seedling emergence or early growth.
Oxford: 114.449.8:114.54. Keywords: Mine spoils, rehabilitation, *Secale montanum, Atriplex canescens.*

With the passage of the New Mexico Coal Surfacemining Act in 1972, much interest has been generated in finding ways to establish vegetation cover on coal mine spoils. The Rocky Mountain Forest and Range Experiment Station has recently entered into cooperative research with several coal mine companies in New Mexico to develop methods of rehabilitating strip-mined areas. Because of widespread interest, these studies are reported even though they are preliminary in scope. More sophisticated work is planned, based on results of the studies reported here.

The problems evaluated were: Will selected plants grow under optimum temperature and moisture on these mine spoils? If not, what is limiting growth? Will the addition of organic matter make a difference to plant growth? Which, of several organic soil amendments, might help? What moisture retention might be expected from selected spoil material?

[1]*Principal Hydrologist and Range Scientist, respectively, Rocky Mountain Forest and Range Experiment Station, located at Albuquerque, in cooperation with the University of New Mexico; Station's central headquarters maintained at Fort Collins, in cooperation with Colorado State University.*

Methods

The 3-year-old spoil material used was taken from the McKinley Mine of Pittsburg and Midway Coal Company, located near Gallup, New Mexico, at an elevation of 6,600-6,800 feet and annual precipitation of 11-15 inches. Characteristics of the spoil material were as follows: Texture — clay loam; pH — nearly neutral; conductivity — shows slight salinity; sodium absorption ratio — shows alkalinity (sodium) in moderate degree to very low; organic matter high due to coal particles.

Moisture drying curves for the spoil materials were prepared from data obtained with a pressure membrane apparatus. Three spoil samples were used at each tension level: Saturation, 0.3 bar, and 15 bars.

Mountain rye (Secale montanum) and fourwing saltbush (Atriplex canescens) were used as test plants in 2.5- by 2.5- by 2-inch pots holding 0.30 pound of spoil material per pot. These species offered promise for growth and survival because previous work on nearby areas showed they were adapted to the climatic conditions of the mine site. Plants were grown in a growth chamber programed for 8 hours at 75°F with light and 16 hours at 65°F in darkness. Distilled water was used throughout,

and all pots were kept at field capacity. This required watering at 2-day intervals. Two separate studies were conducted for 5 weeks.

Study A

A randomized block design was used with three replications of each of the following treatments:

1. Amendments added — none.
2. Manure added at a rate of 10 tons per acre.
3. Bark (ponderosa pine) added at a rate of 10 tons per acre.
4. Straw added at a rate of 2 tons per acre.
5. Sawdust added at a rate of 10 tons per acre.

These amendments were mixed into the spoil material. Twenty seeds of mountain rye and 10 seeds of fourwing saltbush were added to each pot. Seedlings were counted at 3- to 5-day intervals, and height measured to the nearest 1/2 inch at 5 weeks.

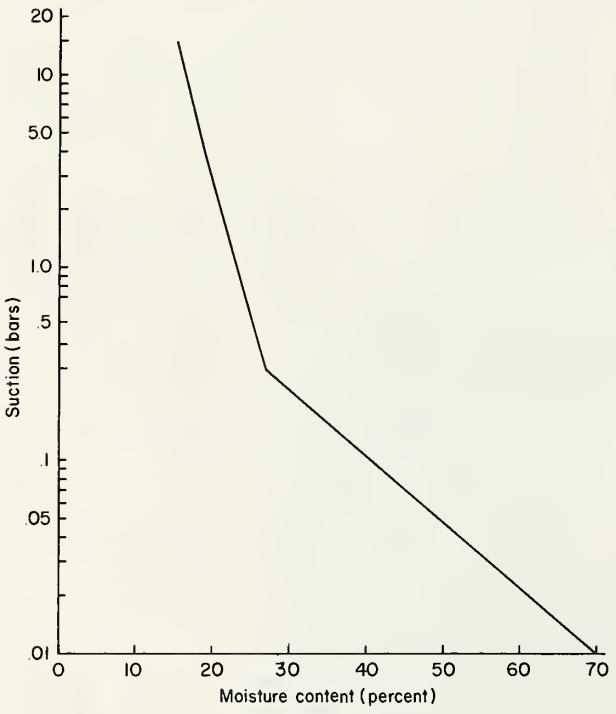

Figure 1.—Drying curve for average of three samples of spoil material from McKinley Mine, near Gallup, New Mexico.

Study B

A randomized block design with three replications of each of the following treatments was used:

1. No fertilizer.
2. Fertilizer (10-5-5) added at a rate of 800 pounds per acre.
3. Fertilizer (10-5-5) added at a rate of 1,600 pounds per acre.

Ten seeds of mountain rye were added to each of three pots, and 10 seeds of fourwing saltbush were used in each of three additional pots. Measurements were taken as in study A.

Results

Moisture-holding capacity of the spoils material is relatively high (fig. 1). At 0.3 bar tension, which approximates field capacity, the three samples averaged nearly 27 percent moisture, whereas at 15 bars, which approximates the wilting point, the samples contained about 15 percent moisture.

Both mountain rye and fourwing saltbush emerged and grew satisfactorily from untreated spoil material. In both studies, seedlings of both species began emerging within 3 to 4 days after seeding. Most seedlings had emerged by the 7th day. Maximum emergence, however, was not attained until the 21st day due to delayed germination of a few seeds.

Adding organic matter to the spoil material did not significantly improve emergence or early growth of mountain rye or fourwing saltbush seedlings (table 1). Five weeks after seeding, maximum emergence of mountain rye averaged about 43 percent and seedling height about 10 inches. Straw appeared to depress emergence and height of the grass slightly, but this effect was not significant.

Fourwing saltbush showed a trend toward better emergence and taller seedlings where organic matter was incorporated in the spoil material (fig. 2), but none of the differences were statistically significant due to relatively large variability among replications.

Fertilizer applied at the time of seeding did not significantly improve emergence or early growth of mountain rye or fourwing saltbush (table 1). The higher rate of fertilizer, in fact, tended to inhibit emergence of mountain rye seedlings for some unexplained reason. Slight trends were shown toward taller seedlings of both species with fertilization.

Figure 2.—Comporotive growth of seedlings in treoted ond untreoted spoils moteriols from McKinley Mine:

Study A—
Spoils treotments (left to right), none, monure, bork, strow, sowdust.
Mountoin rye ond fourwing soltbush.

Study B—
Spoils treotments (left to right), no fertilizer, 800 pounds per ocre, 1,600 pounds per ocre.

Mountoin rye,

Fourwing soltbush.

Table 1.--Effects of amendments on emergence and early growth of mountain rye and fourwing saltbush seedlings from mining spoils

Study and amendment	Rate per acre	Mountain rye		Fourwing saltbush	
		Maximum emergence	Average height[1]	Maximum emergence	Average height[1]
		Percent	*Inches*	*Percent*	*Inches*
STUDY A (Organic matter)					
None		44	9.2	50	2.1
Manure	10 tons	48	10.5	70	2.2
Bark (ponderosa pine)	10 tons	48	10.0	60	2.2
Straw	2 tons	34	9.1	73	2.2
Sawdust	10 tons	40	10.3	83	2.2
STUDY B (Fertilizer, NPK)					
None		67	6.8	90	2.1
10-5-5	800 pounds	60	7.9	83	2.2
10-5-5	1,600 pounds	33	7.6	87	2.3

[1]Study A, 5 weeks after seeding; Study B, 3 weeks after seeding.

Future Work

These studies point up areas for future work. Some leads to be tested are:

1. Find ways to improve moisture penetration into the spoils. Watering was sometimes difficult due to surface crusting and cracking, and could be a major problem under field conditions.
2. Repeat experiments with better detectability in order to determine whether the addition of organic matter does in fact improve emergence of seedlings.
3. Test other plant species that may be useful as forage and ground cover for protection from soil erosion.
4. Test plants grown on spoil material under moisture stress, a situation that might more typify field conditions.
5. Determine effects of fertilization on long-term growth of plants in spoil materials.